SCOPE OF SERVICES
LAKE DIAGNOSTIC STUDY

LAKE AND RIVER ENHANCEMENT (LARE) PROGRAM
IDNR DIVISION OF FISH AND WILDLIFE

I. Project Purposes:

The purposes of the Lake Diagnostic Study include:

1. Describe condition and trends in the lake(s) and its (their) subwatersheds.

2. Identify potential nonpoint source water quality problems.

3. Propose specific direction for future work.

4. Predict and assess success factors for future work.

II. Project Tasks:

The scope of services outlined below should be considered a draft that is subject to revision prior to the final contract, based on discussion with the LARE staff and sponsoring lake association regarding cost-effectiveness of proposed services.

1. Summarize historical information on trends in land use and water quality

Compile an annotated bibliography of all previous studies pertinent to land use and water quality changes in the lake(s) and subwatersheds, including data from volunteer monitoring. Briefly summarize pertinent information on climate, geologic history, topography, trends in land development, unique recreational resources related to the waterway or riparian areas, and water quality.

2. Map and describe current watershed conditions

Present maps and describe current conditions in subwatersheds to the lake(s). Maps and descriptions should include the following:

a. General location maps including watershed boundaries and the associated HUA codes
b. Soil type descriptions and maps of Highly Erodible Land (HEL) and hydric soils
c. Current extent of wetlands and potential wetland restoration sites
d. Floodplain management areas and condition of riparian zones indicating any significant locations possessing or requiring unusual bank protection
e. Significant natural areas
f. General locations of known state and federally listed species
g. Land use information such as:

1) Table of lake and subwatershed sizes
2) Number of lakeside homes and area's development history
3) History of any treatment plant dischargers (point sources) to inlet stream(s) (discharge data available from IDEM).
4) History of pursuit of public access sites
5) Boat count on one weekend and one week day
6) Land use categories by acreage and percent of watershed area
7) Map of broad land use categories
8) Location of large septic fields or industry
9) "Hot spots" of damaging land use practices
10) Number and type of animals in confined animal feeding operations (CAFO's) in watershed(s)
11) Tillage transect data/trends in the county(ies)

Note that land use information should be reported at a relatively large resolution, not on a "field-by-field" basis. The report should not include information specific to individual landowners. All land-use information should be collected and discussed with the sponsoring lake association and the local county Soil and Water Conservation District, the local staff of the USDA Natural Resources Conservation Service and ISDA Division of Soil Conservation in the watershed prior to inclusion in reports.

3. Collect and analyze information on water quality

Conduct water quality tests at pertinent sites in the lake and its tributaries. Sites should be selected with input from staff of the LARE program, lake association, IDNR District Fisheries Biologists and staff from the county Soil and Water Conservation District (SWCD), the ISDA Division of Soil Conservation, and the USDA Natural Resources Conservation Service. Collect and analyze data on water quality, biological communities, and habitat, as indicated in "a" through "c" below.

a. Lake sampling
If an eutrophication index has been determined by the IDEM Clean Lakes Program (Contact: Bill Jones of the Indiana University-School of Public and Environmental Affairs (SPEA) program) from a representative year within the past five years, the only further in-lake sampling would be a Secchi depth reading in mid-summer. Otherwise, one sample should be taken at the surface and bottom over the deepest part of each lake in late summer (at peak stratification, typically in July or August) for purposes of calculating the IDEM Trophic State Index (ITSI) and Carlson's Trophic State Index (TSI).

Parameters include: Secchi depth, light penetration, conductivity, pH, temperature, dissolved oxygen, nitrate + nitrite, organic nitrogen (TKN), ammonia nitrogen, total and dissolved phosphorus, turbidity, plankton, and chlorophyll-a. A vertical profile of temperature and dissolved oxygen at one meter intervals should be taken at the same locations.

b. Tributary sampling:
Conduct tests at tributary sampling sites on physical and chemical water quality, including: pH, temperature, dissolved oxygen, nitrate + nitrite, organic nitrogen (TKN), ammonia nitrogen, total and dissolved phosphorus, turbidity, conductivity, and discharge. Fecal coliform as *E. coli* should be sampled at these sites, if appropriate. Stormflow and baseflow samples should be collected at each tributary site. Site locations should be well documented on maps with photos, longitude/latitude georeferencing, and GPS coordinates as available. The 14 digit Hydrologic Unit Codes (HUC) provide an additional point of reference that should be considered for inclusion.

c. Quality assurance:
Water quality analyses must be conducted by a reputable laboratory and should follow analytical methods described in the most recent edition of one of the following publications:

1) Standard Methods for the Examination of Water and Wastewater jointly published by the American Public Health Association (APHA), the American Water Works Association (AWWA), and the Water Environment Federation (WEF). (web link: http://www.standardmethods.org/)

2) Methods for the Chemical Analysis of Water and Wastes, US EPA, Environmental Monitoring and Support Laboratory. (EPA Publication # 600479020-Published March, 1983) (web link: http://tinyurl.com/yzuyzx)

Water quality analysis must be conducted using detection limits appropriate for the analysis of lake water samples. The following detection limits are suggested for LARE projects:

Parameter	Limits (mg/l)
Total Phosphorus	0.01
Total Orthophosphorus	0.01
Ammonia Nitrogen	0.03
Nitrate Nitrogen	0.10
Total Kjeldahl Nitrogen	0.10
Total Suspended Solids	4

Quality assurance/quality control procedures (QA/QC) must be a part of the sampling and water quality analysis. A copy of the QA/QC plan from the laboratory(s) conducting the water and sediment sample analysis must be provided to the LARE section's office in Indianapolis.

4. Habitat Quality

The following information must be compiled or developed:

a. Water Budget

A water budget for the lake must be calculated if not done in a previous study. The hydraulic residence time of the lake(s) should be determined using data available from various sources. Describe how the hydraulic residence time may affect the predicted success of treatment efforts.

b. Lake Shoreline and Streambank Erosion

Map lake shoreline protection and erosion areas from existing engineering information, indicating the approximate extent and distribution of various seawall materials. Describe any water quality or habitat changes that have occurred along eroding areas.

c. Sedimentation

If sediment removal from the lake or tributaries is under consideration, the Sediment Removal Plan requirements developed by LARE should be followed. Where available, previous studies proposing sediment removal, including results of sediment sampling, should be referenced.

5. Biological Community Quality

a. Fish and macroinvertebrate communities:

1) A monitoring program should be followed using the same methods employed by the Indiana Department of Environmental Management and must be designed according to Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition (US EPA publication number EPA/440/4-89/001) (web link: http://www.epa.gov/owow/monitoring/rbp/).

    a) Bioassessment Protocol for benthic macroinvertebrates, consisting of identification at the lowest feasible taxonomic level for a 100-organism subsample for the riffle/run sample and a leaf-pack sample where applicable;
    b) Water quality evaluation, following the Water Quality section of the Field Data Sheet in the EPA manual;
    c) A habitat evaluation, using the Qualitative Habitat Evaluation Index (QHEI) as used by the Indiana Department of Environmental Management (IDEM) conducted once at each site and photographs of each sampling site at each monitoring event which show relevant conditions of the site
    d) An analysis of the correlation between habitat and biotic scores.

2) Each site should be biologically monitored a total of two times, once in spring (i.e., mid-April to mid-May) to obtain a representative sample of the Plecopterans and Tricopterans and once in fall (i.e., mid-September to mid-

October) to capture shredders and other groups under low-flow conditions. Each site will be monitored before land treatment is initiated (or as soon as possible following land treatment initiation) and approximately one year following project completion and within the same time frame as the initial monitoring. Site locations should be well documented on maps, with photos, latitude/longitude georeferencing, and GPS coordinates when available.

3) A voucher collection will be submitted to IDNR Division of Fish and Wildlife at the same time as the draft report is submitted, allowing two months for review by IDNR or outside specialists. The collection will be forwarded to the Department of Entomology, Purdue University. A voucher for each taxon identified at each site will be curated according to Purdue's protocols for specimen handling, as follows:

    a) Use a 2 dram vial with a neoprene stopper and 70 to 80% ethyl alcohol;
    b) Label format must include state, county, stream, location, date, collecting firm, contract or project number, voucher specimen;
    c) Identification to lowest taxonomic level indicated for the protocol;
    d) Vials tagged with two identification labels in the following format:
        A. taxonomic name, the individual who identified the specimen, and the date, for example

Baetis flavistriga Collected by: J. Doe October 2005

        B. state and county where collected, exact location, date, collector, for example

IN: Greene Co. Indian Creek at C.R.500N Date: 05-10-2006 Collected by: S. Beach

    e) Data sheet that indicates the number of individuals, taxon, location of collection, and vial number of voucher specimen.

A Scientific Purposes License is not needed to sample aquatic insects. A fishing license or Scientific Purposes License is needed to collect crayfish, depending on the number and manner in which the crayfish will be taken. The only mussels that can be taken or possessed are Asiatic clams, quagga mussels and zebra mussels without a Scientific Purposes License. Individuals should not touch a mussel, or even just a dead shell, unless they know for sure that it is one of these three species listed above. Otherwise, a Scientific Purposes License is required to collect or possess a native mussel or dead shell.

For threatened and endangered species, adhere to the restrictions imposed by the Scientific Purposes License.

The study should include reports and brief analysis of surveys, trends, and management

recommendations from biological studies conducted in the lake and tributaries. Information on the lake's fish community may be obtained from IDNR Division of Fish and Wildlife's Fish Management Reports or other sources. Macroinvertebrate data for selected Indiana lakes is available from the Biological Studies Section of the Assessment Branch, Office of Water Quality, Indiana Department of Environmental Management (IDEM). The data should be included in the final report as an indication of water quality trends in the lake.

b. Aquatic plants:
The sponsoring organization should consult with the LARE staff to determine how expansive the aquatic plant portion of the diagnostic study should be. In some cases, it may be adequate to simply conduct a single "Tier II" survey in late summer (i.e., July 15 – August 31) to obtain basic plant community information (see below). In other cases, it may be more appropriate to have a consultant perform the work necessary to develop a complete long-range Aquatic Vegetation Management Plan.

In either case, at least some form of aquatic plant survey should be conducted in the lake. Aquatic plants should be identified to the species level, when possible, and mapped according to their distribution following the IDNR Tier II Sampling protocol (Shuler and Hoffmann, 2002-web link at: http://www.in.gov/dnr/fishwild/lare/manual.html under the section titled "Guidance for Consultants"). Plants that may be of interest to the IDNR Division of Nature Preserves should be curated in accordance with the procedures outlined in their aquatic plant survey memorandum.

Because wetland conservation is a significant issue in the lake and tributaries, the study should include a general description of the diversity and condition of wetland plants in the area. Where the wetland plant community has not developed adequately for protection of water quality, make recommendations for improving or protecting the wetland community.

Plankton samples need only be collected as part of the calculation of the Eutrophication Index. The methods specified the IDEM Indiana Trophic State Index (TSI) (web link at: http://www.in.gov/idem/programs/water/305b/2006integrept/appc_305b303dmethodology.doc) should be followed to ensure that the samples are collected and analyzed correctly. A list of plankton species and abundance should be included, based on collections made for calculation of the TSI. Attention should be paid to the identification and concentration of toxin producing blue-green genera such as *Cylindrospermopsis*.

c. Nuisance species:
If waterfowl, other nuisance wildlife or exotic invasive species (e.g., purple loosestrife, Eurasian water milfoil, zebra mussels) are of concern in the lake or watershed, a survey of the current count or distributions of the species should be conducted on a representative day.

6. Analyze trends relating physical, chemical, biological, and habitat factors

Use statistical analyses to predict the relationships between physical, chemical, and habitat factors compared to biological quality. Indicate potential limiting factors. Predict the success of the recommended treatments in regard to eutrophication, recreational use, fisheries productivity or other factors related to ecological quality and human uses. Describe trends in water clarity and quality, compare water quality with similar regional lakes, and set a reasonable goal for improvement in water quality factors.

7. Model nonpoint source pollution in lakes and subwatersheds

Appropriate models should be used to describe relative contributions to sediment and nutrient loads from identified or predicted sources of nonpoint pollution. A Vollenweider nutrient loading figure or similar illustration may be included with an interpretation. Indicate the potential benefit derived from changes in land use practices. Various computer modeling methods are available and may be useful in describing changes. Intensive modeling programs may represent a higher level of resolution than is necessary for the purposes of this study, but there may be smaller areas of particular interest where more intensive models would be appropriate.

8. Prioritize management recommendations

The study should list and prioritize potential watershed land treatment projects, which would contribute to decreases in degradation from nonpoint source pollution. It should describe unusual physical or social characteristics of the subwatersheds or institutions that may support or challenge future lake or watershed projects. It should include cost estimates and recommended timelines for implementation, as well as briefly listing potential sources of funding for projects. It should identify motivating factors that would encourage voluntary participation of land users in future programs. Set specific goals or targets when possible.

9. Create a public information handout

Create and distribute an information handout that addresses factual issues concerning the state of the lake and costs or benefits predicted from the proposed project. The format of the handout should be tailored to the specific needs of the local sponsor, such as a 2-page flier, bi-fold brochure or magazine-style article.

10. Facilitate a final public meeting

Facilitate at least one public meeting for the purpose of presenting the final report. Document meeting attendance, minutes, and perceptions.

11. Report project progress

Issue monthly progress reports during the duration of the project. Copies of progress reports must be submitted to the project sponsor and LARE program staff.

12. Completed lake diagnostic study report

Should include the following items at a minimum:

a. Executive Summary

b. Statement of project purpose

c. General overall project description

d. Heading and summary for each project task with accompanying appendices, if necessary. Appendices should include (if applicable) but are not limited to:

1) All pertinent data, including field sheets.

2) Water quality and index calculations

3) Computer model input and output

4) All pertinent project correspondence

5) Necessary maps, charts, graphs, computations and computational breakdowns

6) Pertinent meeting agendas, attendance lists and agreements

e. Project conclusion

III. Data Presentation:

1. Where practical, the data should be presented clearly and concisely in the form of graphs and tables

2. Raw data sheets need not be bound into each copy of the report. However, at a minimum, one set of all laboratory and field data sheets must be forwarded to the LARE program office to aid in the review of the draft report

3. Figures should be incorporated into the main body of the report and not presented as attachments at the end of the report

4. Whenever possible, figures should be limited to 8 1/2" x 11" in size. In most cases, large-scale blueprint drawings and photos are not necessary

5. Present data in metric units with English units in parentheses. Example: 1.5m (5ft). Similarly, use common names for species with scientific names in parentheses or include a chart with all common and scientific names used in the document.

IV. Review Process:

1. Four printed copies and one digital copy of the draft report must be provided to the LARE program office for review by the LARE staff and pertinent agencies and organizations. The LARE staff will forward copies for review by other persons and agencies.

2. Both the draft and final reports should be reproduced with double-sided pages.

3. The title of the draft report should refer to the report as a "draft" version. Additionally, each page of the draft report and plan sheets should be labeled "Draft - Subject to Revision."

4. To facilitate review of the draft report, a meeting between a representative of the local sponsor organization, consultant, and LARE staff may be held to discuss the review comments. This review process will be coordinated by LARE staff and normally takes at least eight weeks.

5. Upon addressing the review comments, three bound printed copies of the complete final report and plan sheets should be provided to the LARE office for distribution to the participants involved in the lake and watershed initiative. In addition, one unbound printed copy shall be provided to the LARE office, along with a single electronic file that contains the **complete digital copy of the full report including appendices, figures, maps and photos in either Microsoft Word© or Adobe PDF© format** which is internet-ready for enhanced public access to the information.